MI-NOTE: #0188

Main Injector and Beamline Naming Conventions

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Introduction

The goal of this note is to specify a unique, unambigious Main Injector BEAMLINE NAMING convention and TUNNEL LOCATION designation convention for the MI and associated beamline tunnels that remains consistant with existing beamline conventions. This convention may be utilized to construct a database of all devices installed in the tunnel with their location, serial numbers, installation date, and in the case of dipoles and quads, their harmonics. In addition, this convention will form the basis for device names and eventually ACNET control system names.

Main Injector lattice description

The MI lattice has been described in the Main Injector Technical Design Handbook but will be described further here. The MI lattice design contains normal arc cells using 84 inch quads and dispersion suppressor cells using 116 inch quads. The match between the dispersion suppressor cells and the arc cells or straight section cells utilize 100 inch quads. The normal arc half-cell is defined from quad center to quad center (F to D or D to F) and has an arc length of 17.288639 meters. The dispersion suppressor half-cells are also defined from quad center to quad center and have a length of 12.966479

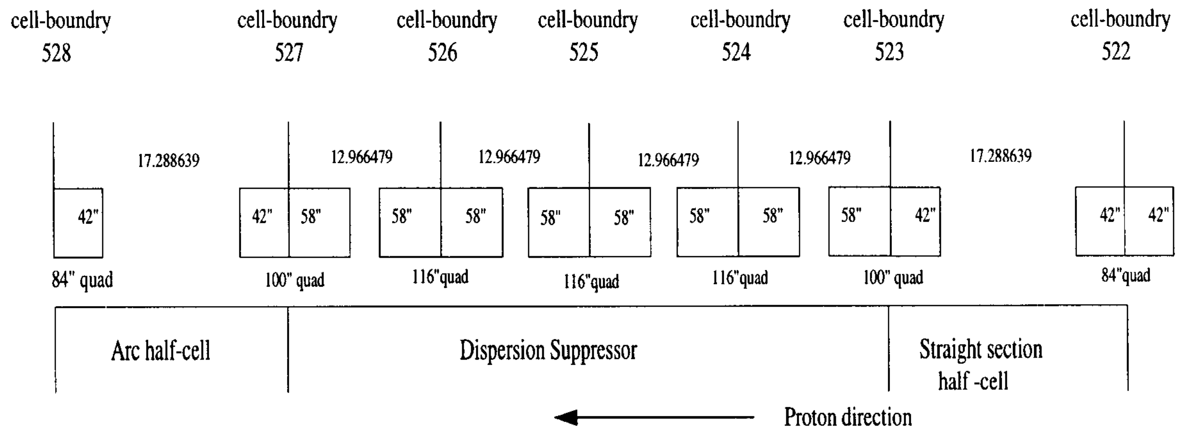

Figure 1: Orientation of the dispersion suppressor insert between a straight section cell and arc cell.

meters (exactly 3/4 of the normal arc half-cell length). Figure 1 shows an example of the cell boundaries for the dispersion suppressor insert at the downstream end of the MI-52 straight section. This figure shows only the quads and has omitted the dipoles in this region as well as any correctors or auxillary devices. Note that the cell boundaries 523 and 527 are not in the CENTER of the 100 inch quads because they are at the transition between the dispersion suppressor half-cells and either arc or straight section half-cells. This implies that the 100 inch quads are made up of one-half arc quad (42 inches) and one-half dispersion suppressor quad (58 inches).

The Main Injector tunnel design and civil construction has been based upon these quad cell boundaries.

Conventions

Beam directions

All devices in the Main Injector and associated beamlines, including quads, dipoles, and mini-straights, are numbered in ascending order in the direction of the primary beam travel. In most beamlines and the ring, the primary beam is considered to be protons. The exception to this rule, and there

MUST always be at least one exception, is the transfer line, originating from MI-62, for 150 GeV/c pbars from the MI to the Tevatron for which the primary beam is considered to be pbars.

The direction of travel for the proton beam in the Main Injector is counter-clockwise, as it is in Booster. This is in contrast to the Tevatron where the protons circulate in the clockwise direction. The magnets are installed against the radially outside wall of the Main Injector tunnel and the Tevatron tunnel, but are installed along the radially inside tunnel wall in Booster. **NOTE:** This means that when one is inside the Main Injector tunnel, looking at the ring, protons travel from right to left where as in the Booster *and* Tevatron, protons travel from left to right.

Main Injector Ring Naming Convention

The motivation and description of the general naming scheme of the Main Injector ring has already been described in MI note#0054. The following summary of the MI sectors, quad cell boundaries, and Service Buildings is, however, included as a reference.

Table 1: Sector, Straight Section and Quad Cell Boundaries

Sector	Straight Sections	Quad Cell Boundaries	Service Buildings
10	MI-10	100 - 130	MI-10
20	MI-22	201 - 232	MI-20
30	MI-30 , MI-32	301 - 341	MI-30
40	MI-40	400 - 430	MI-40
50	MI-52	501 - 532	MI-50 , MI-52
60	MI-60 , MI-62	601 - 641	MI-60 , MI-62

It should be noted again that a single quad is associated with each cell boundry in the MI ring, while in the beamlines, there may be multiple quads located at a cell boundry, and in the Recycler (and parts of the 8 GeV line) there are multiple permanent gradient magnets located at a cell boundry.

Beamline Naming Convention

The naming of the beamlines associated with the MI (and subsequently the Recycler) should represent an easily recognizable scheme to determine whether a device is in the ring or beamline. The convention adopted for the Main Injector ring and beamlines (*and Recycler*) is simular to that used in the Switchyard and Anitproton Source and utilizes a three character label for quad locations (cell boundaries) The first character specifies the sector or beamline and the second and third characters specify the position (or cell) within the sector or beamline. For example, the fourth cell boundary in the MI sector 5 is 504 while the fourth cell boundary in the beamlines from the MI to the Tevatron would be 704 or 904, for the proton and pbar lines, respectively. Additionally, in the MI and Recycler ring *and* all new beamlines, the last 2 digits of the quad location specifies whether that location is focusing or defocusing. **Even cell boundries are horizontally focusing while Odd cell boundries are horizontally defocusing.**

The MI to Recycler ring transfer lines are currently located between MI-30 and RR-22 (located above MI-22) for pbar injection into the RR (MI→ R), and between MI-30 and RR-32 (located above MI-32) for pbar extraction from the RR (RR→MI). The MI→ RR transfer line would be denoted as the R:700 series devices while the RR→ MI transfer line would be denoted as the R:900 series magnets. This means that pbars in the RR would travel through the R:900 line, the MI, and then the I:900 line to get into the Tevatron.

The first part of Table 2, above the double line, spells out the convention for the MI and RR. Included in the table are the existing ring and beamline names. Although not part of the nomenclature, the prospective accelerator controls front-end node name has been added as a prefix only to illustrate the distinction, for example between the MI A150 beamline and the Recycler AP5 beamline. NOTE: This AP5 beamline does not exist, even on paper, at this time, however should anyone ever dream up such a beamline in the future this nomenclature would exist.

Table 2: Beamline Naming Convention

Area	Beamline	Name	Primary Function
MAIN INJECTOR	RING	I:100-I:600	ring sectors
	P150	I:701	150 Gev/c protons MI->Tev
	8 GEV	I:800	8.9 GeV/c protons B->MI
	A150	I:901	150GeV/c pbars MI->TeV
	ABORT	I:001	proton abort
	P2(F0-17)	M:F11-F17	protons to AP1 beamline
	P3(F18-A0)	M:F18-A0	protons to Switchyard
	NUMI	N:101	120 GeV/c protons to NuMI stub
RECYCLER	RING	R:100-R:600	ring sectors
	ABORT	R:001	proton abort line
	MI22	R:701	pbar transfer MI->RR
	MI32	R:901	pbar transfer RR->MI
	AP5	R:800	pbar transfer ACC->RR
TEVATRON	RING	T:Axx-Fxx	
SWITCHYARD	EXT	S:090	
	NEUTRINO	S:100	
	MESON	S:200	
	PROTON	S:300	
	MUON	S:400	
ANTIPROTON	AP1	M:100	120 GeV/c protons MI->Target
	AP2	D:700	8.9 GeV/c pbars Target->DEB
	AP3	D:900	8.9 GeV/c pbars ACC->MI
	DtoA	D:800	8.9 GeV/c pbars DEb->ACC
	AP4	REMOVED	8.9 Gev/C protons B->DEB
	ACC ring	A:100-A:600	
	DEB ring	D:100-D:600	

Definition of Tunnel Location Nomenclature

The convention for labeling tunnel locations is designed to aid in keeping track of device destinations in the tunnel. This convention is envisioned to be carried over to device labeling and potentially to cabling conventions. This convention should be consistent throughout the rings and beamlines. All locations (and subsequent device names) are keyed with the adjacent quad or cell boundry number since the devices are usually associated with the adjacent quad. The tunnel location specification is made up of four parts:

- a three character CELL BOUNDARY number where the meaning of each of the three characters was described above in the section on beamlines.
- a decimal point (.) delimiter or letter (A or B) in the case of multiple quads at the specified cell boundry.
- the first alphanumeric character after the dp (.) represents either a major device (single numeric character), straight section device (alpha character S), or a mini-straight device (an alpha character U, D, or C for the upstream (U) or downstream (D) mini-straight or in the case of multiple quads the space between the quads (called the center mini-straight).
- a second numeric character (or sequence identifier) to represent the relative location within the designated mini-straight or major device, increasing in beam direction.

The convention is illustrated in Figure 2 for a location with a single quad as in the MI ring and Figure 3 for a multiple quad location as in the 8 GeV line. The case where multiple gradient magnets are loacted at a cell boundry is analogous to that of multiple quads and will not be treated separately. This convention is utilized in the 8 GeV line and the Recycler ring.

Figure 2 displays the first couple of half-cells from Figure 1. It shows the relative orientation of the major devices, straight section, and mini-straight. The top row displays the tunnel location designation. For the purposes here any device contained between the steel of the quad and the steel of the adajcent dipole is considered to be within the mini-straight. This distance is NOT the available space in which devices can be inserted. In the case of a quad adjacent to or in a straight section the mini-straight is considered to be from the quad steel to the end of the quad beamtube or to the edge of the steel of the adjacent major straight section device. A description of the tunnel location convention for the the example in Figure 2 is provided by Table 3. This explains the parts of the tunnel location convention for the half-cell 523 in the MI.

Figure 3 illustrates the tunnel and device location for half-cell 811 in the 8 GeV line. Here, this cell boundry has two quads separated by a short distance which act as a single D quad. Both quads and all devices on either side and between them are referenced to the cell boundry. Some locations in the 8 GeV line, as well as the Recycler, contain two permanent gradient magnets. In this case, the quads in figure 3 would be replaced by the gradient magnets. The quad (or gradient magnet) locations are denoted by the addition of an A and B to the end of the cell boundry. The space between the upstream dipole and upstream quad is denoted as the upstream mini-straight (although, for this example, there are no devices currently installed in this location), the space between the quads is called the central or center mini-straight, and the space between the downstream quad and dipole called the downstream mini-straight. The TUNNEL LOCATION ID is pictured on the top row with the element names below each device. Table 4 provides a description of the tunnel location convention for the example in figure 3.

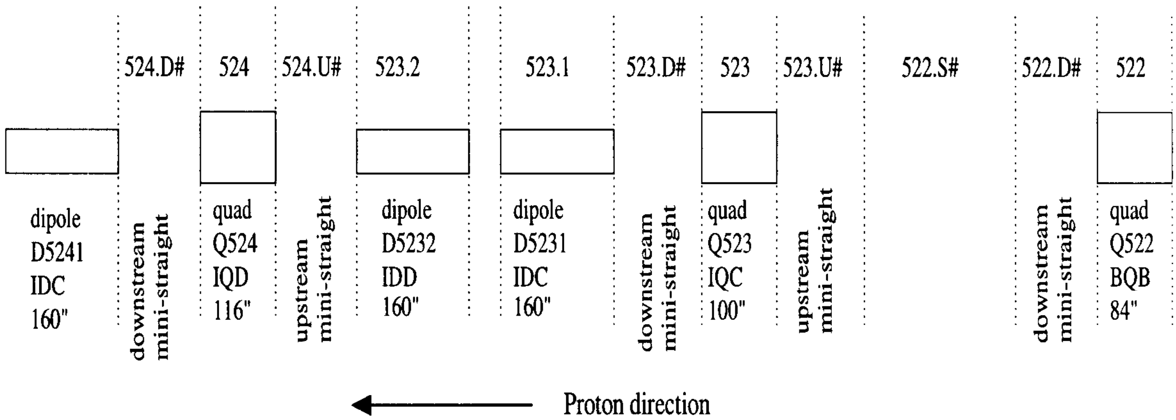

Figure 2: Device location, name, and type layout in a MI straight asection and dispersion suppressor half cells. The top row is the TUNNEL LOCATION ID's, next are the element type, device name, device type, and element length.

Table 3: Tunnel Location Nomenclature for Single Quad Locations

523	this is the cell boundary or quad location
523.1	this specifies the first dipole downstream of the quad in proton direction (the direction of increasing cell boundary numbers)
523.2	this specifies the second dipole downstream...
523.U#	this specifies the location and order of the devices in the upstream "mini-straight" associated with quad 523. The order numbers,#, would be 1,2,3, etc in increasing order in the proton direction. This would be true for the downstream devices as well. The "mini-straights" would include all devices between the dipole steel (or major device flange) and quad steel .
523.D#	this specifies the downstream devices, with the same comments as above.
523.S#	this specifies the major devices in the straight section, between quad beam tubes.

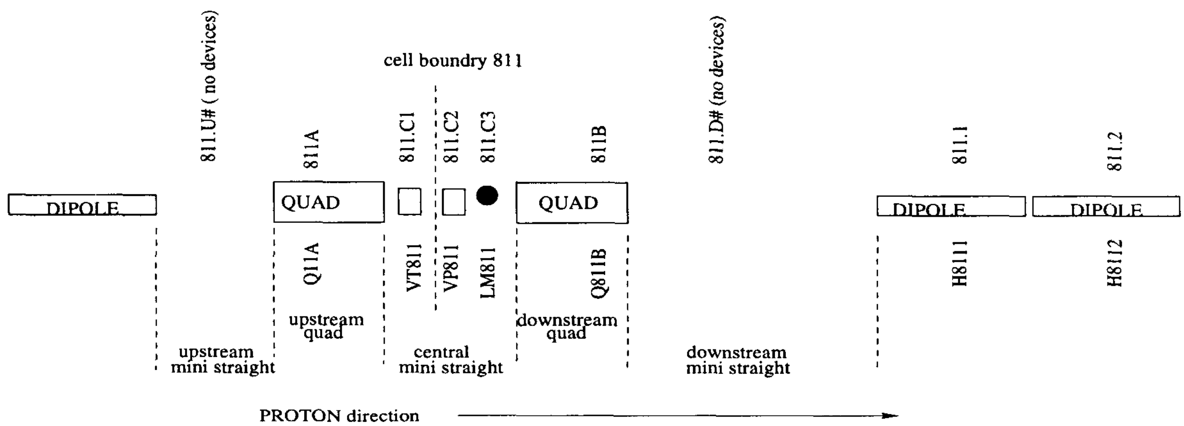

Figure 3: Device location, name, and type layout at the location 811 in the 8 GeV line. The top row is the TUNNEL LOCATION ID's, next are the element type, device name, device type, and element length.

Table 4: Tunnel Location Nomenclature for Multiple Quad Locations

811	this is the cell boundary or quad location
811A	denotes the upstream quad (or gradient magnet)
811B	denotes the downstream quad (or gradient magnet)
811.1	this specifies the first dipole downstream of the quads in proton direction (the direction of increasing cell boundary numbers)
811.2	this specifies the second dipole downstream...
811.U#	this specifies the location and order of the devices in the upstream "mini-straight" associated with quads 811A and 811B.
811.C#	this specifies the major devices in the central mini-straight between the quads 811A and 811B. The sequence identifier numbers,#, would be 1,2,3, etc. in increasing order in the proton direction.
811.D#	this specifies the downstream devices, with the same comments as above.

Main Injector Mini-straights

In the MI, two "mini-straights" are associated with each quad in the arc or dispersion suppressor cell, an upstream and downstream mini-straight. Correction elements and/or other devices that are associated with a particular quad may be located in either mini-straight. Figure 4 shows a half-cell and the devices within the mini-straight. The top row of names are *device* names while the bottom row are the location within the 514 half-cell. Notice that the upstream mini-straight contains four devices while the downstream ministraight contains five. In this example, there are two skew quads in the upstream mini-straight. To distinguish between the two magnets a sequence number (1 or 2) is appended to the name. They are called SQ5141 and SQ5142 and are in the locations 514.U2 and 514.U3, respectively. The last two devices in the downstream mini-straight are located at the same distance along the beamline. Here we have an ion pump and a pump-out port which occupy locations 514.D4 and 514.D5, respectively.

To take advantage of symmetry, quad mini-straight "types" have been defined for use to aid in the design of the quad beamtube lengths and vacuum system. These have been grouped according to quad length and device contents. These types are used to describe the *contents* of the mini-straights around each quad. These types have been used to generate the lattice, determine quad beamtube lengths, and determine vacuum connections, and document quad mini-straight. They are numbered according to quad length as outlined in Table 5.

Table 5: Quad Mini-straight Types

Quad length	Allowed Types	Assigned Types
84"	01 thru 20	01 thru 12
100"	21 thru 40	21 thru 30
116"	41 thru 60	41 and 42

The lengths of these mini-straights are determined by the quad type (arc, dispersion, matching). For example, the 84 inch quads in the arcs have 51.173 inches between the quad and dipole steel in both the up and downstream mini-straights. However, subtracting coil protrusions and bellows the real

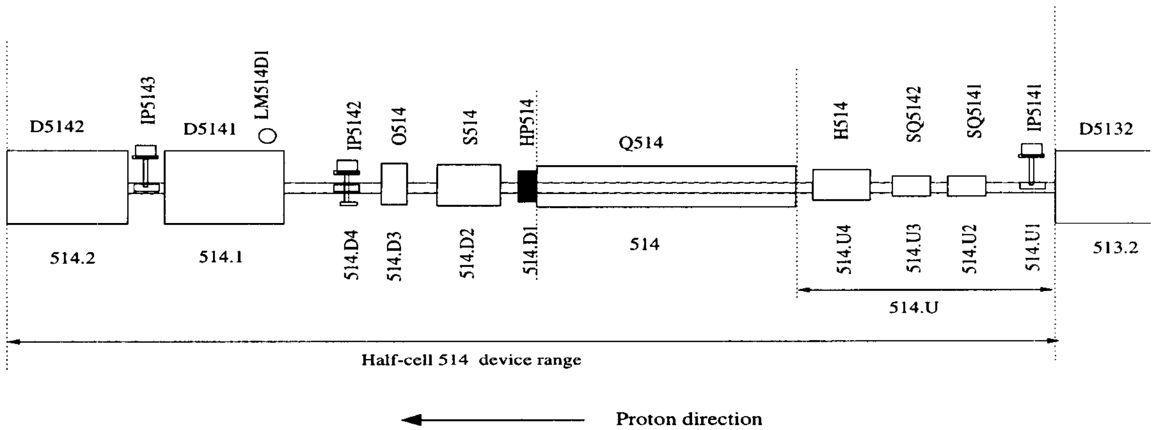

Figure 4: Example of devices within a MI quad mini-straight.The labels on the top row illustrate device names while the lower row illustrates tunnel locations.

"available" space to insert devices is reduced to 38.258 inches on either side of the quad.

The 116 inch quads have 30.135 inches between the quad and dipole steel. Subtracting the coil protrusions and bellows the useable space is reduced to 18.374 inches in the upstream and 17.744 inches in the downstream mini-straight.

The length of the up and downstream mini-straights for the 100 inch quads is dependent on location (mini-straight type). For example, in the mini-straight next to the arc for types 21 and 22 there are 51.193 inches quad to dipole steel (of which only 38.898 inches are usable) and on the dispersion suppressor side of the quad the quad dipole steel distance is 30.154 inches (of which only 18.394 inches are usable). The available space next to the straight section it is dependent on quad beamtube length.

The contents and number of each type of quad mini-straight is listed in Table 6.

Table 6:Quad Mini-Straight Inventory for 84, 116, and 100 inch quads.

Type	No.	UPstream					DOWNstream						
		.U1	.U2	.U3	.U4	.U5	.D1	.D2	.D3	.D4	.D5	.D6	.D7
01	30	IP	H				HP	S	O	IP	PP		
02	32	IP	V				VP	S	IP	PP			
03	16	IP	Q	H			HP	S	O	IP	PP		
04	6	IP	V				VP	S	O	IP	PP		
05	4	IP	SQ	SQ	H		HP	S	O	IP	PP		
06	8	IP	SQ		V		VP	S		IP	PP		
07	2	IP	BV	V			VP	S	O	IP	PP		
08	2	IP	BV	V			VP	S	IP	PP			
09	10	H					HP						
10	13	V					VP						
11	4												
12	1												
21	4	IP	H				HP	S	IP	PP			
22	4	IP	V				VP	S	IP	PP			
23	4	BV	H				HP						
24	3	BV	V				VP						
25	4	IP	H				HP						
26	4	IP	V				VP						
27	4	IP	H				HP	BV					
28	2	IP	V				VP	BV					
29	1	V					VP						
30	2	IP	V				VP						
41	24	IP	H				HP						
42	24	IP	V				VP						

Table 7: Partial list of device mnemonics

Mnemonic	Device	Mnemonic	Device
H	horizontal corrector	O	octupole
V	vertical corrector	HP	horizontal bpm
QC	quad corrector	VP	vertical bpm
SQ	skew quad	IP	ion pump
S	sextupole	BV	beam vlalve
PP	pump out port assembly		

Device Names

The device naming convention allows all physical devices in the ring and tunnel to have a unique, descriptive name. It is based upon a 1 to 3 character device description plus the three character tunnel location. A description of this convention and currently accepted device mnemonics are given in a companion MI note #189.

An example of the TUNNEL LOCATION and DEVICE naming convention for part of sector 5 (from half-cell 516) through the 150 GeV proton line to the Tevatron injection Lambertsons is given in Tables 8A-8D..

Table 8A: Example 1: 150 GeV line Device

TUNNEL LOCATION	DEVICE NAME	DEVICE TYPE	SERIAL NUMBER	DATE INSTALLED
516.U1	IP516	IP		
516.U2	H516	IDH		
516	Q516	IQC		
516.D1	HP516	MIBPM		
516.1	D5161	IDC		
516.2	D5162	IDD		
517.U1	IP517	IP		
517.U2	V517	IDV		
517	Q517	IQD		
517.D1	VP517	MIBPM		
517.1	D5171	IDC		
517.2	D5172	IDD		
518.U1	IP518	IP		
518.U2	H518	IDH		
518	Q518	IQD		
518.D1	HP518	MIBPM		
518.1	D5181	IDC		
518.2	D5182	IDD		
519.U1	IP519	IP		
519.U2	V519	IDV		
519	Q519	IQD		
519.D1	VP519	MIBPM		
519.1	D5191	IDC		
519.2	D5192	IDD		
520.U1	IP520	IP		
520.U2	H520	IDH		
520	Q520	IQC		
520.D1	HP520	MIBPM		
520.D2	BV520	BV		
520.S1	K52A	K		
520.S2	K52B	K		

Table 8B: Example 1: 150 GeV line Device

TUNNEL LOCATION	DEVICE NAME	DEVICE TYPE	SERIAL NUMBER	DATE INSTALLED
520.S3	ES52A	ES		
520.S4	ES52B	ES		
521.U1	V520	IDV		
521	Q521	BQB		
521.D1	VP521	MIBPM		
521.D2	H552	IDH		
521.S1	L52A	ILA		
522	Q552	BQB		
522.D1	HVP552	LGBPM		
522.S1	L52B	ILA		
522.S2	L52C	ILA		
522.S3	CM522	ICA		
701.U1	HT701	MRHC		
701.	Q701	3Q120		
701.D1	VP701	8BPM		
701.D2	VT7011	MRVC		
701.D3	VT7012	MRVC		
701.1	V7011	ICA		
701.2	V7012	ICA		
701.3	V7013	ICA		
702	Q702	3Q120		
702.D1	HP702	8BPM		
702.D2	HPR702	SYBPM_S		
702.D3	VPR702	SYBPM_S		
702.D4	HT702	MRHC		
703	Q703	BQB		
703.D1	VP703	MIBPM		
703.D2	VT7031	MRVC		
703.D3	VT7032	MRVC		
703.1	HV7031	B2		
703.2	HV7032	B2		

Table 8C: 150 GEV LINE

TUNNEL LOCATION	DEVICE NAME	DEVICE TYPE	SERIAL NUMBER	DATE INSTALLED
704	Q704	BQB		
704.D1	HP704	MIBPM		
704.D2	HT7041	MRHC		
704.1	HV7042	B2		
705	Q705	BQB		
705.D1	VP705	MIBPM		
705.D2	VT7051	MRVC		
705.D3	VT7052	MRVC		
705.1	HV7051	B2		
705.2	HV7052	B2		
706	Q706	BQB		
706.D1	HP706	MIBPM		
706.D2	HT7061	B2		
706.1	HV7062	B2		
707	Q707	BQB		
707.D1	VP707	MIBPM		
707.D2	VT7071	MRVC		
707.D3	VT7072	MRVC		
707.1	HV7071	B2		
707.2	HV7072	B2		
708	Q708	BQB		
708.D1	HP708	MRHC		
708.D2	HT7081	B2		
708.1	HV7082	B2		
709	Q709	BQB		
709.D1	VP709	MIBPM		
709.D2	VT7091	MRVC		
709.D3	VT7092	MRVC		
709.1	HV7091	B2		
709.2	HV7092	B2		

Table 8D: 150 GEV LINE

TUNNEL LOCATION	DEVICE NAME	DEVICE TYPE	SERIAL NUMBER	DATE INSTALLED
710	Q710	3Q10		
710.D1	HP710	8BPM		
710.D2	HT710	MRHC		
710.1	HV7101	B2		
710.2	HV7102	B2		
711	Q711	3Q120		
711.D1	VP711	8BPM		
711.D2	VT7111	MRVC		
711.D3	VT7112	MRVC		
712.A	Q712A	3Q120		
712.B	Q712B	3Q60		
712.D1	HP712	8BPM		
712.D2	HT712	MRHC		
713.A	Q713A	3Q120		
713.B	Q713B	3Q60		
714	Q714	3Q120		
714.D1	HP715	8BPM		
714.D2	HPR714	SYBPM_S		
714.D3	VPR714	SYBPM_S		
714.D4	VT7141	MRVC		
714.D5	VT7142	MRVC		
714.1	CM714	ICA		
714.2	L7141	ILA		
714.3	L7142	ILA		
714.4	L7143	ILA		
714.5	L7144	ILA		